

REMARKS

Claims 14-27 are pending. By this Amendment, Claims 14 and 16-18 are amended, and new Claims 19-27 are added. Reconsideration of the June 19, 2002 Official Action is respectfully requested.

Claim 14 was rejected under 35 U.S.C. § 112, first paragraph, enablement requirement. The reasons for the rejection are set forth in numbered paragraph 2 of the Official Action. The rejection is respectfully traversed.

Applicants note that the reasons for the rejection stated in the Official Action pertain to the subject matter of Claim 16, and not to Claim 14. Claim 16, as amended, recites "the one or more fluorine-containing compounds is selected from the group consisting of CF_4 , CHF_3 , C_2F_6 , CH_2F_2 , and C_nF_{n+4} ". It is asserted in the Official Action that "subscript 'n' is non-enabling for fluorine-containing compounds that have the structural formula, C_nF_{n+4} , when n is 1 or 3". Applicants respectfully disagree with these assertions.

Claim 16 recites the formulas CF_4 and C_2F_6 . C_2F_6 is the formula where n in the formula C_nF_{n+4} equals 2. Another exemplary compound is C_4F_8 , where n in the formula C_nF_{n+4} equals 4. The formula C_nF_{n+4} encompasses operative embodiments, but, for example, does not encompass CF_5 .

As explained at MPEP § 2164.01, the test for enablement is whether one skilled in the art could make or use the invention from the disclosure in the application together with information known in the art without undue experimentation. Further, as explained at MPEP § 2164.08(b), the presence of inoperative embodiments within the scope of a claim does not render it non-enabled where one skilled in the art of the invention would be able to

determine operative embodiments without undue experimentation. Applicants submit that one skilled in the art of the invention would not have to conduct undue experimentation to determine operative embodiments encompassed by the formula C_nF_{n+4} . Rather, such information is well known in the art and could readily be obtained by a skilled artisan.

For the foregoing reasons, Applicants submit that Claim 16 is sufficiently enabled by the disclosure to comply with 35 U.S.C. § 112, first paragraph. Accordingly, withdrawal of the rejection is respectfully requested.

Claims 17 and 18 were rejected under 35 U.S.C. § 112, second paragraph. The reasons for the rejection are stated in numbered paragraph 4 of the Official Action. The rejection is respectfully traversed.

Claim 17 has been amended to recite "consists essentially of". Claim 18 has been amended to recite the unit "sccm" for the gas flow rates. Support can be found at page 8 of the specification. Withdrawal of the rejection is respectfully requested.

Claims 14 and 16 were rejected under 35 U.S.C. § 102(b) over U.S. Patent No. 4,214,946 to Forget et al. ("Forget"). The reasons for the rejection are stated at numbered paragraph 6 of the Official Action. The rejection is respectfully traversed.

Claim 14, as amended, recites "an oxygen-free plasma etching gas formulation for removing an organic ARC on a metallic layer comprising one or more fluorine-containing compounds, an optional inert carrier gas and chlorine, the gas formulation being free of SE_6 " (emphasis added). Support for the amendments to Claim 14 can be found at page 4, lines 2-4, and page 6, lines 3-8, of the specification. Forget does not disclose the combination of features recited in Claim 14.

Forget discloses an etch gas composition that consists of SF₆ and Cl₂ diluted with an inert gas. Forget emphasizes that the combination of SF₆ and Cl₂ in the etch gas composition achieves unexpected results as compared to "conventional plasma etching" using CF₄ or CF₄ + O₂ (paragraph bridging columns 6 and 7). Forget discloses that "[t]his is a clear case of synergism where the combination of Cl₂ + SF₆ unexpectedly is superior to Cl₂ or SF₆ alone" (emphasis added). Forget does not disclose an etching gas mixture that is free of SF₆. In fact, Forget clearly discloses that SF₆ (and Cl₂) must be contained in the etching gas mixture to achieve unexpected synergistic effects.

Accordingly, Claim 14 is patentable. Dependent Claim 16 is thus also patentable. Withdrawal of the rejection is respectfully requested.

Claims 15 and 18 were rejected under 35 U.S.C. § 103(a) over Forget in view of U.S. Patent No. 5,573,679 to Mitchell et al. ("Mitchell") and U.S. Patent No. 4,208,241 to Harshbarger et al. ("Harshbarger"). The reasons for the rejection are stated at numbered paragraph 8 of the Official Action. The rejection is respectfully traversed.

Claim 15 recites the "one or more fluorine-containing compounds is CHF₃ and the inert carrier gas is argon" (emphasis added). The combination of features of Claim 15 is not suggested by the applied references.

As explained above, Forget discloses an etch gas composition that consists of SF₆ and Cl₂ diluted with an inert gas, and that the etch gas composition achieves unexpected results due to "a clear case of synergism". Forget clearly discloses that SF₆ must be combined with Cl₂ to achieve its unexpected synergistic effects, and thus teaches away from using a fluorine-containing gas other than SF₆.

It is acknowledged in the Official Action that Forget does not disclose that one or more fluorine containing compounds is CHF_3 , as recited in Claim 15. However, it is asserted in the Official Action that Mitchell "teaches sulfur hexafluoride as an effective etchant and also other effective (fluorine containing) etchants include trifluoromethane . . . which suggest either etchant can be used". It is further asserted in the Official Action that it would have been obvious to have modified Forget's SF_6 using CHF_3 as taught by Mitchell "for the purpose of obtaining the best-etched semiconductor" (emphasis added). Applicants respectfully disagree with these assertions.

Mitchell discloses an etchant for etching through layers of a structure depicted in FIG. 2E (see column 6, line 66 to column 7, line 19). Mitchell discloses that pure sulfur hexafluoride (SF_6) is effective. Mitchell does not suggest that SF_6 could be used with any other gas. Mitchell further discloses other gases, which could be used with or without oxygen, including tetrafluoromethane, trifluoromethane (CHF_3), hexafluoroethane and nitrogen trifluoride. Mitchell discloses that these other gases can be used by themselves, or with oxygen. Mitchell does not suggest using chlorine in the etchant.

As explained above, Forget discloses that SF_6 must be used with Cl_2 to achieve unexpected synergistic effects. Mitchell, on the other hand, discloses that SF_6 should be used alone to achieve effective results. Thus, Mitchell teaches away from Forget.

Mitchell further discloses fluorine-containing compounds that could be combined with oxygen. However, Forget teaches away from using oxygen in plasma etching (column 6, lines 55-57). Moreover, Mitchell does not suggest the use of chlorine in the etchant. Thus, Mitchell does not suggest that the same unexpected results obtained by Forget using

$\text{SF}_6 + \text{Cl}_2$ could be obtained by substituting CHF_3 for SF_6 in Forget's etch composition. Mitchell clearly does not suggest that this substitution would result in the "best-etched semiconductor", as asserted in the Official Action. Accordingly, because Forget's and Mitchell's disclosures with respect to etchant compositions are contrary to each other, these references are not properly combinable. For the foregoing reasons, Claim 15 is patentable.

It is acknowledged in the Official Action that Forget and Mitchell do not disclose the combination of features of Claim 18. Harshbarger is cited with respect to the subject matter of Claim 18. Harshbarger does not cure the deficiencies of Forget and Mitchell, because Harshbarger does not suggest gas flow rate ratios for Forget's etching gas mixture specifically containing SF_6 , Cl_2 and inert gas. Accordingly, Claim 18 is also patentable. Withdrawal of the rejection is respectfully requested.

Claim 17 was rejected under 35 U.S.C. § 103(a) over Forget in view of WO 97/30472 to Abraham et al. The reasons for the rejection are stated at numbered paragraph 9 of the Official Action. The rejection is respectfully traversed.

Claim 17 has been rewritten in independent form. Claim 17, as amended, recites "[a]n oxygen-free plasma etching gas formulation, which consists essentially of CHF_3 , Ar, and Cl_2 , wherein the gas formulation has a composition effective to remove an organic ARC disposed on a metallic layer while minimally affecting a pattern of a photoresist disposed on the organic arc" (emphasis added). Support for Claim 17 can be found in the paragraph bridging pages 5 and 6 of the specification. As explained above, Forget does not suggest using CHF_3 .


Abraham discloses using a $\text{Cl}_2/\text{Ar}/\text{CHF}_3$ etch chemistry to etch a TiN ARC (see the paragraph bridging pages 12-13). Abraham does not suggest modifying Forget's specific etch gas composition to replace SF_6 with CHF_3 . Abraham discloses etching a TiN ARC, while Forget discloses selective reactive ion etching of polysilicon against silicon dioxide. As explained above, Forget discloses unexpected results, which rely on "clear synergistic effects" achieved by specifically combining SF_6 and Cl_2 . Forget and Abraham do not suggest that the same unexpected results could be achieved by modifying Forget as asserted in the Official Action. As explained above, Forget does not suggest using CHF_3 . Moreover, Claim 17 recites that the gas formulation "has a composition effective to remove an organic ARC disposed on a metallic layer while minimally affecting a pattern of a photoresist disposed on the organic arc". The references provide no motivation to modify Forget's gas composition to achieve the recited gas formulation. Accordingly, Claim 17 is patentable. Withdrawal of the rejection is respectfully requested.

New Claims 19-23 depend from Claim 14, Claim 24 depends from Claim 15, and Claims 25-27 depend from Claim 17. Support for Claims 20 and 25 can be found at page 5, lines 12-15 of the specification. Claims 19-27 are also patentable for at the least the reasons stated for Claims 14 and 17.

For the foregoing reasons, it is submitted that the application is in condition for allowance and such action is earnestly solicited.

Respectfully submitted,

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Marked-up Claims 14 and 16-18

14. (Amended) An oxygen-free plasma etching gas formulation for removing an organic ARC on a metallic layer comprising one or more fluorine-containing compounds, an optional inert carrier gas and chlorine, the gas formulation being free of SF₆.

16. (Amended) The oxygen-free plasma etching gas formulation of Claim 14, wherein the one or more fluorine-containing compounds is selected from the group consisting of CF₄, CHF₃, C₂F₆, CH₂F₂, [SF₆,] and C_nF_{n+4}.

17. (Amended) [The oxygen-free plasma etching gas formulation of Claim 14, wherein the system of etching agents consists essential of CHF₃, Ar, and Cl₂.] An oxygen-free plasma etching gas formulation, which consists essentially of CHF₃, Ar, and Cl₂, wherein the gas formulation has a composition effective to remove an organic ARC disposed on a metallic layer while minimally affecting a pattern of a photoresist disposed on the organic ARC.

18. (Amended) The oxygen-free plasma etching gas formulation of Claim 15, wherein a ratio of flow rates of CHF₃:argon:chlorine in the formulation is 5 to 80 sccm:5 to 80 sccm:5 to 60 sccm.